Using HICO data for the preparation of the EnMAP satellite mission

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EnMAP Hyperspectral Imager

Environmental Mapping and Analysis Program

- Germany's first hyperspectral earth observing satellite mission.
- Scientific path finder mission for later operational services.
- Provide high-quality calibrated image products on a frequent basis.
- To observe a wide range of ecosystem parameters.
- To extend the scientific and technical know-how.
- One of the foreseen standard products of the EnMAP processing chain is atmospheric correction on water and on land

DLR

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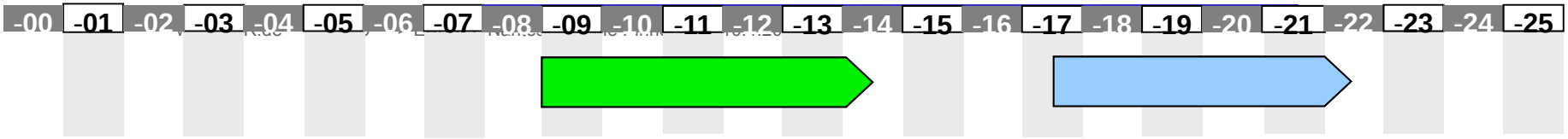
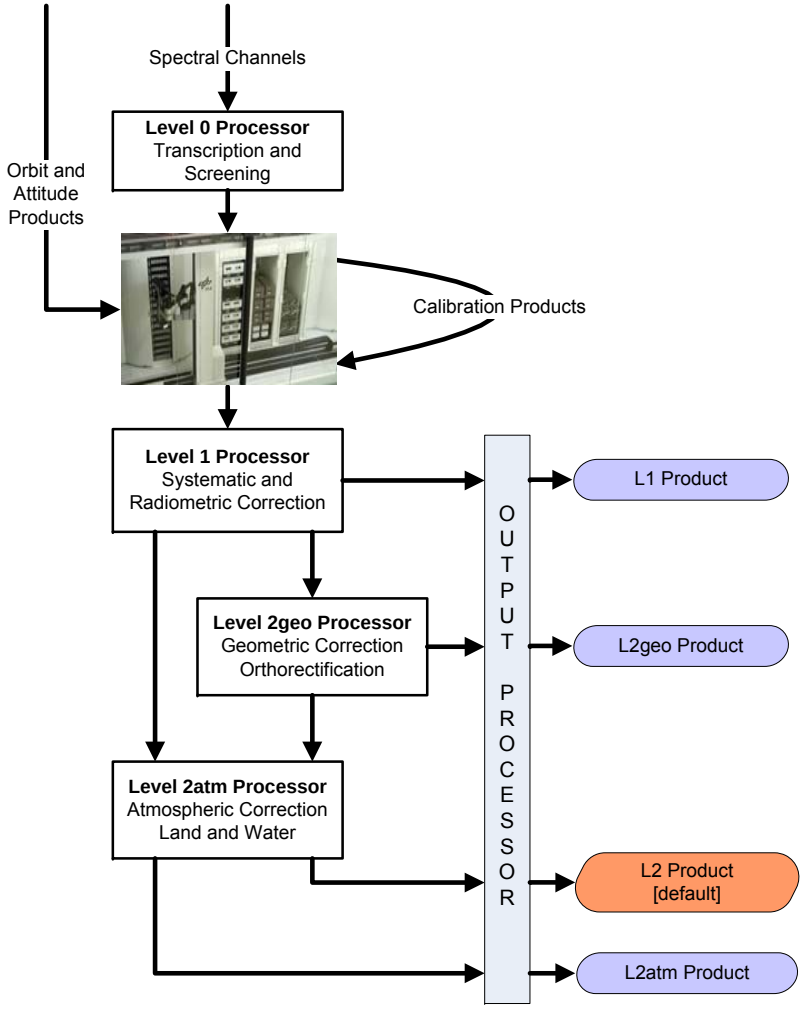
The Hyperspectral Imager for the Coastal Ocean (HICO)

- First spaceborne imaging spectrometer for coastal oceans
- Samples coastal regions at <100 m (400 to 900 nm: at 5.7 nm)
- High signal-to-noise ratio to resolve the complexity of the coastal ocean
- Sponsored as an Innovative Naval Prototype (INP) by the Office of Naval Research: Goal to reduce cost and a greatly shortened schedule.
- Start of Project to Sensor Delivery in 16 months
- Launched to the ISS September 10, 2009



Parameter	HICO (NRL, USA)	EnMAP (DLR, Germany)
Mission	Observing coastal regions	Scientific operational mission for environmental monitoring
Spectral Range	380 nm – 960 nm	420 nm – 1000 nm (VNIR) 900 nm – 2450 nm (SWIR)
Bandwidth	5.7 nm	6.5 nm ± 1.25 nm (VNIR) 10 nm ± 2.50 nm (SWIR)
No of Bands	102 bands	98 bands (VNIR), 130 bands (SWIR)
Spatial Resolution	92 m	30 m
Swath	42 km	30 km
Orbit	350 km	Near-Polar Sun-Synchronous at 653 km
Revisit	3 days (+45° to -30° across track pointing)	≤ 4 days (± 30° off-nadir tilt) and ≤ 21 days (± 5° off-nadir tilt)
Specialities	Onboard of ISS, data access for scientists	Mission fully funded

Level 2atm land/water scene processing



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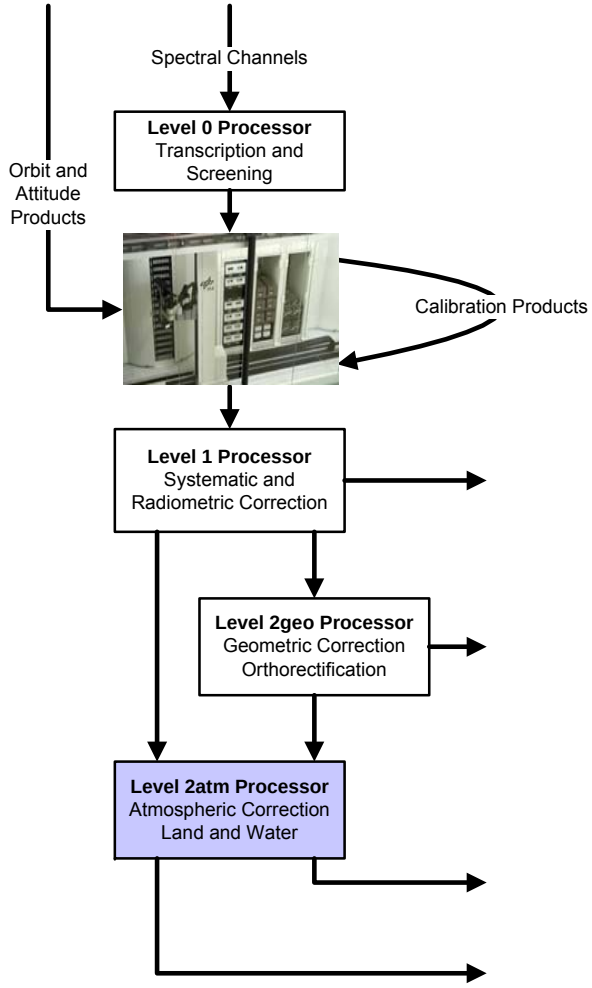
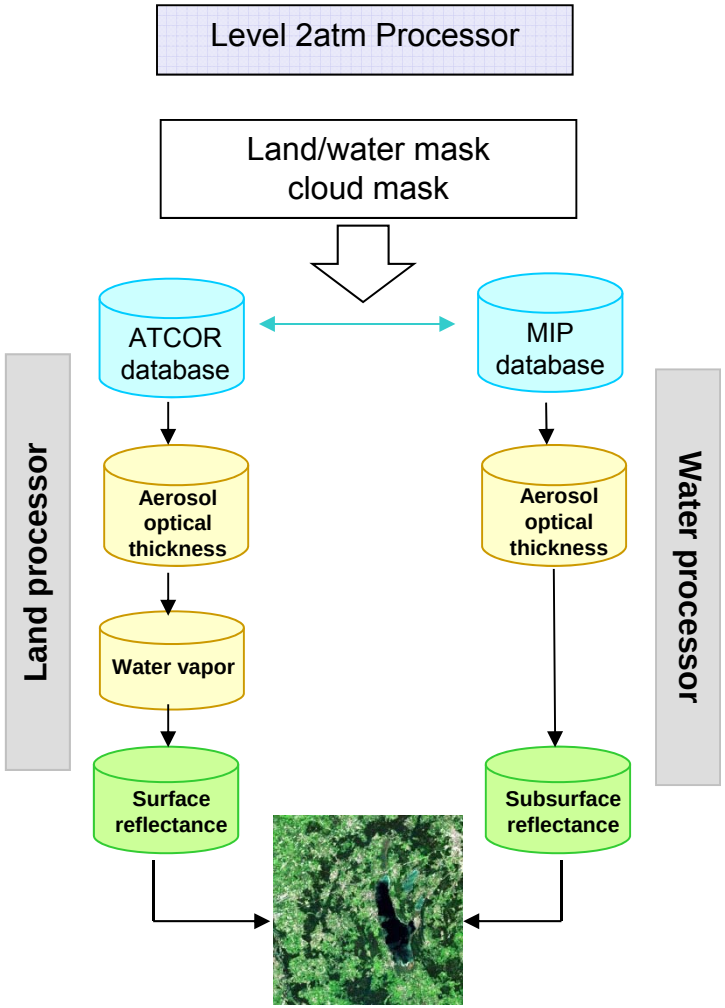




HICO data processing

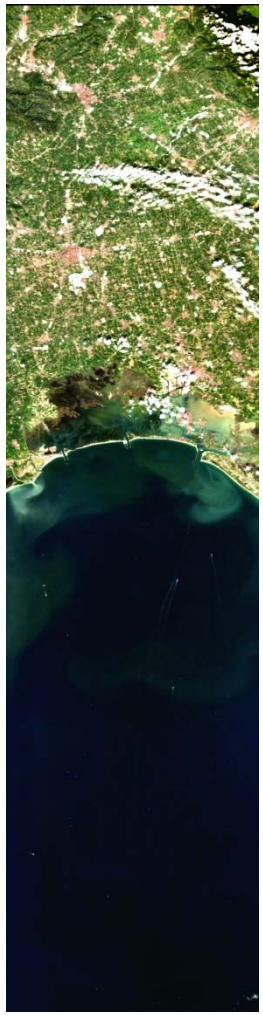
Tafkaa 6s (Montes et al. 2004).
- Developed by Naval Research Laboratory (NRL)
- Based on ATmospheric REMoval (ATREM) 4.0
- uses Second Simulation of the Satellite Signal in the Solar Spectrum (6S) for its scattering calculations

ATCOR (Richter 1996; 1998, 2008, 2011)
- Based on Modtran5 atmosheric model
- The EnMAP pre-processing chain on land will be performed with the ATCOR atmospheric correction code.

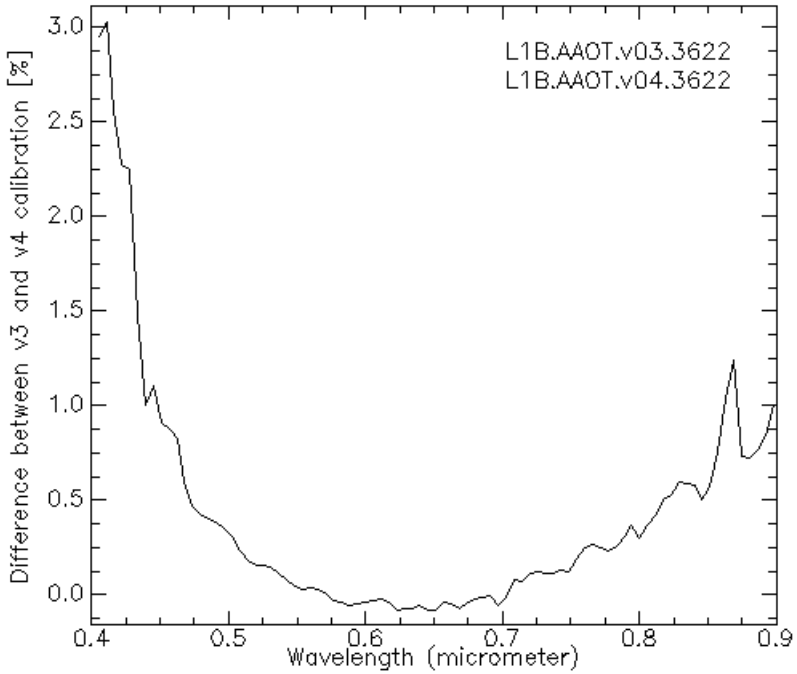
Modular Inversion Program (MIP) (Miksa et al. 2004; Heege et al. 2005,)
- Combines Finite Element Method (FEM) and Modtran4 atmospheric model
- MIP will be used within the EnMAP pre-processing chain for atmospheric correction over water targets

Intercomparison of calibrated radiance data
(Version 03 and 04)

HICO Scene L1B.AAOT.v03.3622 and Scene L1B.AAOT.v04.3622



from 8th August 2010 at AAOT in Venice



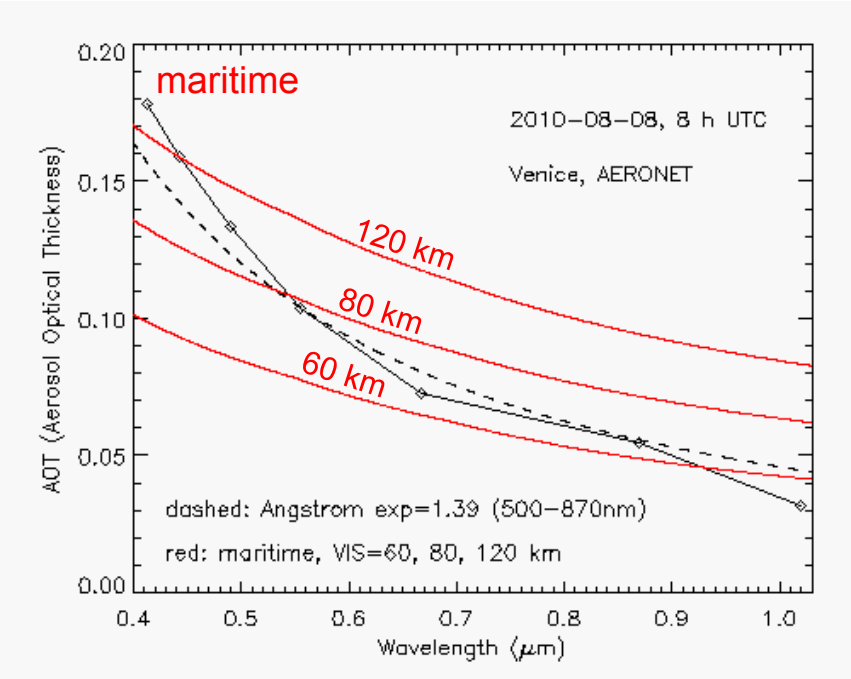
Observed differences between calibration version 03 and 04 :

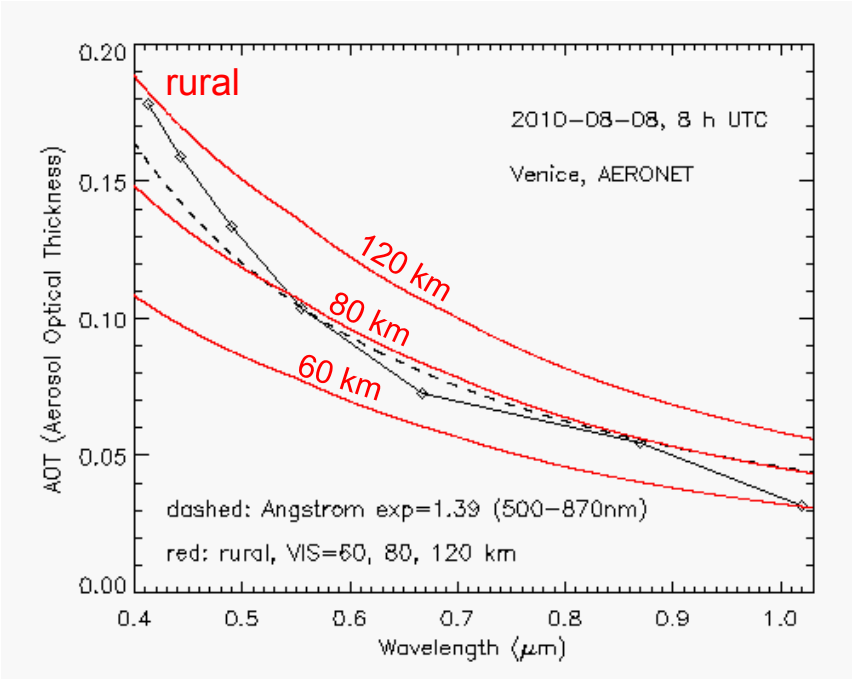
- 2.9 % at 445 nm
- 1 % at 860 nm
- 0.9 nm spectral shift

“HICO™ Data provided by the Naval Research Laboratory.”

Aerosol Optical Thickness (AOT)

HICO Scene L1B.AAOT.v03.3622 from 8th August 2010 at AAOT in Venice





Data are provide by Giuseppe Zibordi, JRC from AERONET (http://aeronet.gsfc.nasa.gov)

Comparison of ATCOR and Tafkaa 6s processing

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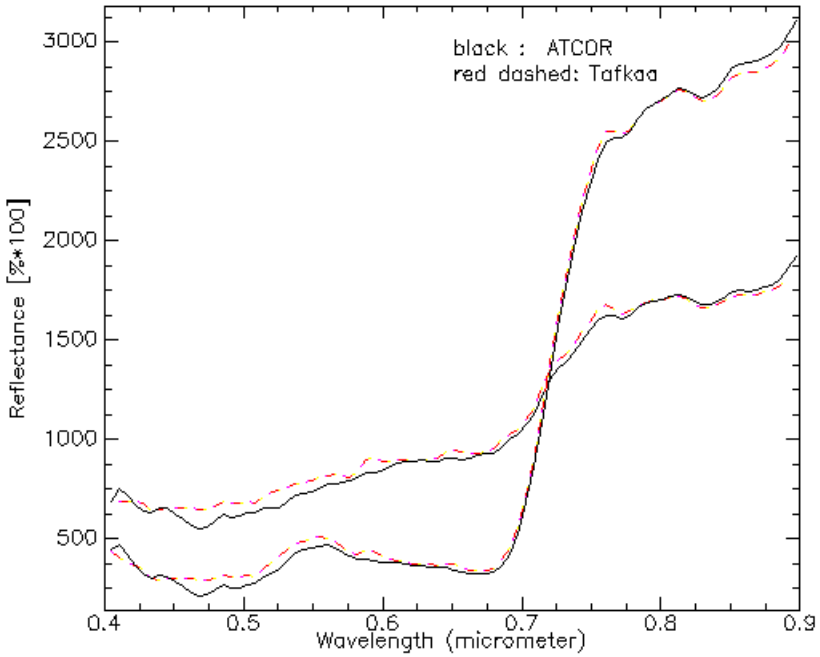

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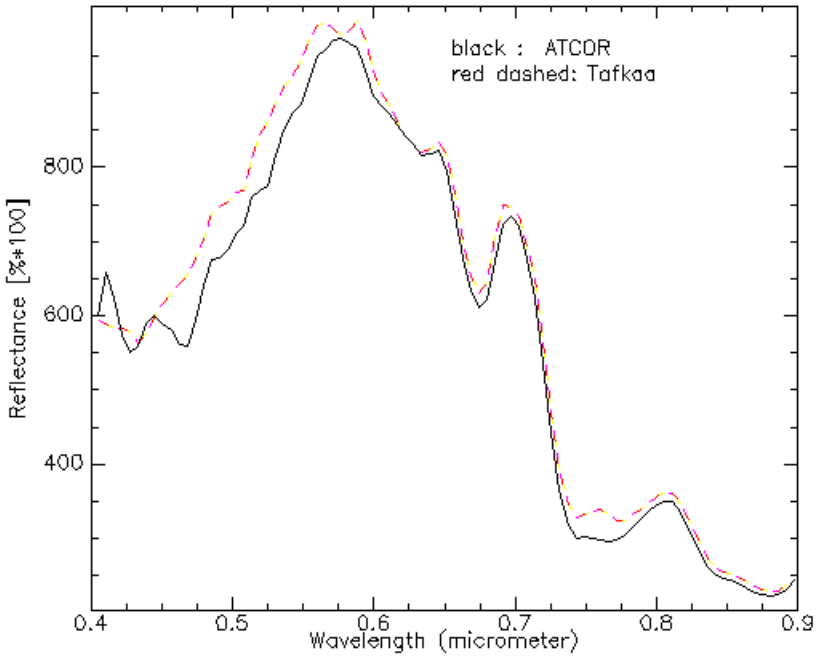

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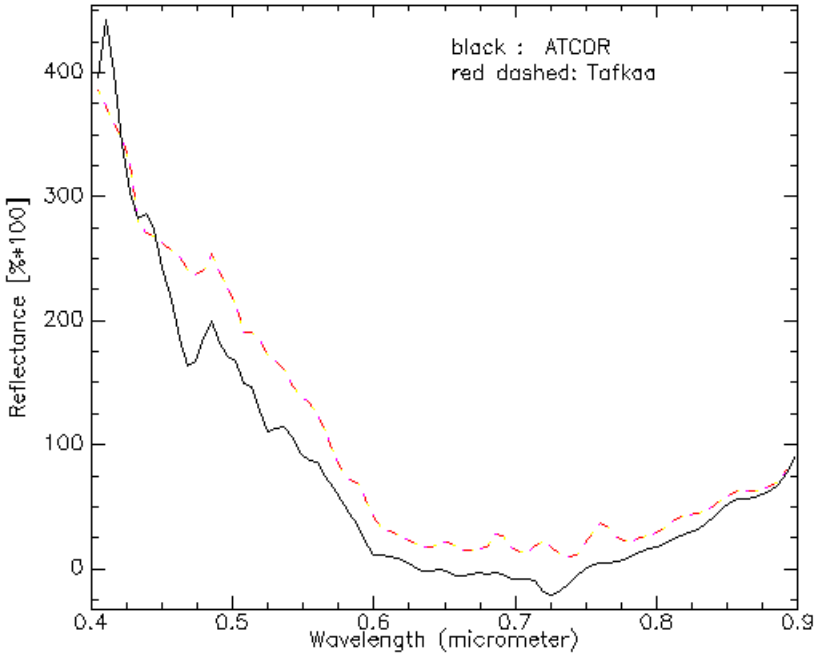

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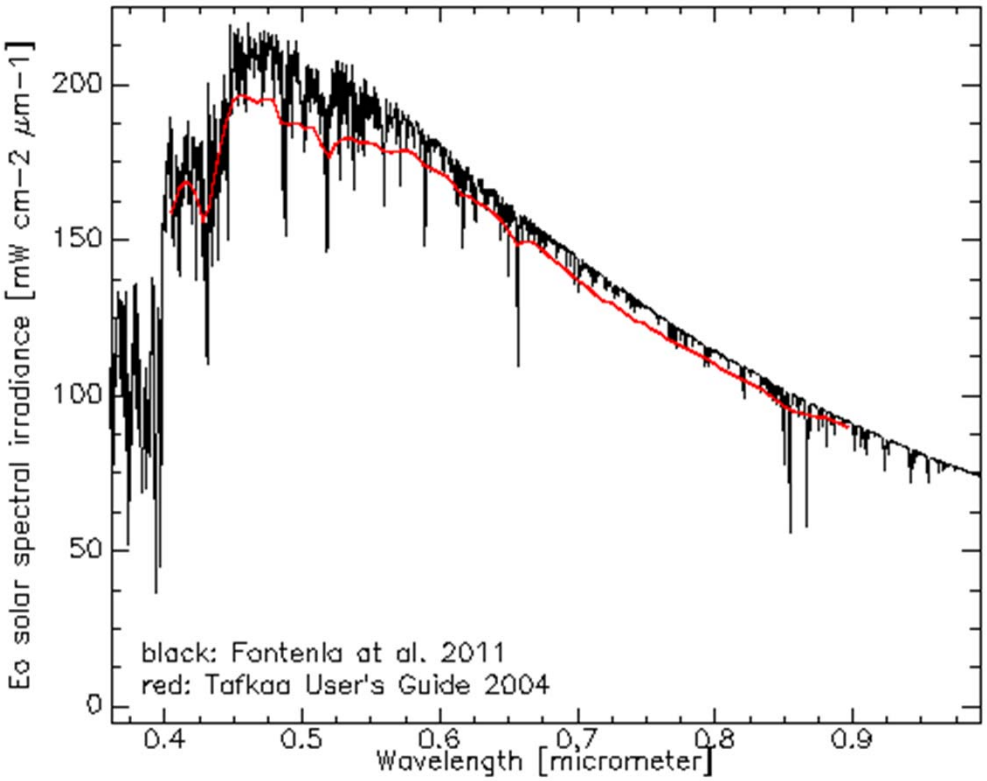
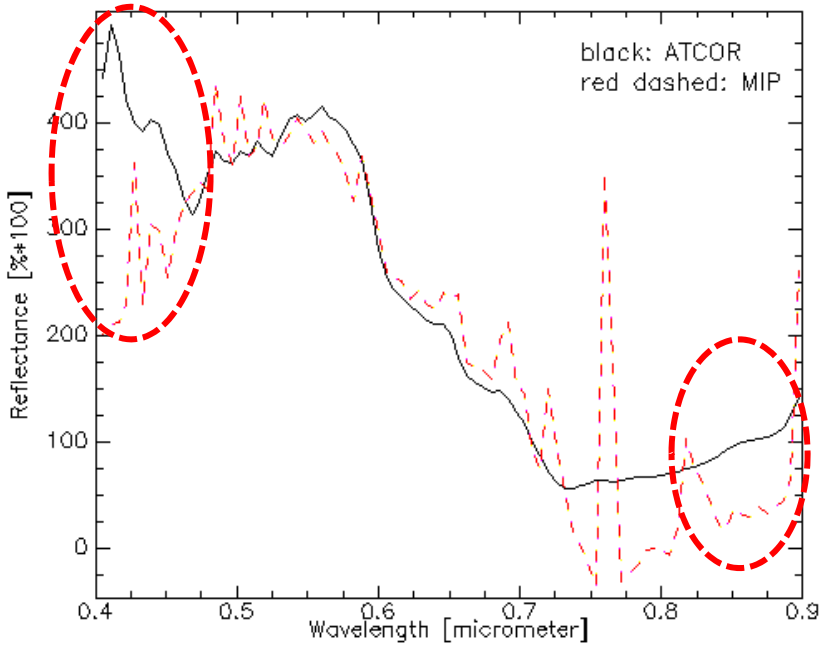
Intercomparison EO Solar irradiance



Comparison of ATCOR and MIP processing

HICO Scene L1BM.AAOT.v03.7339 from 22nd July 2011 at AAOT in Venice



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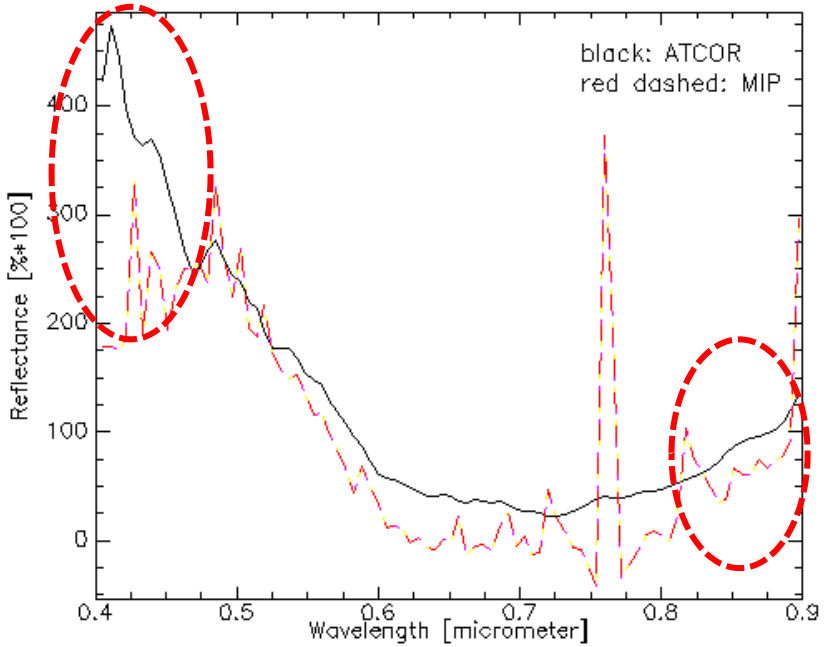

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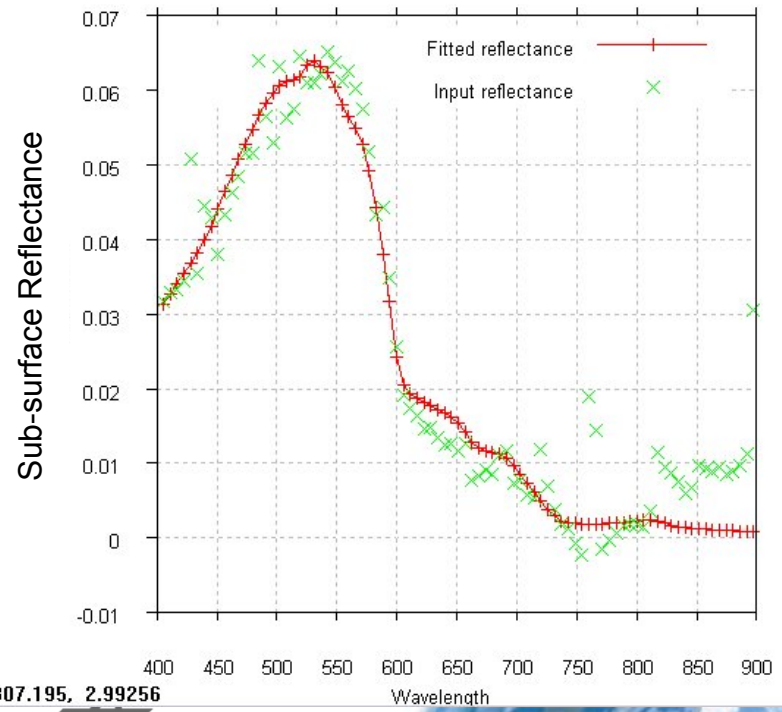
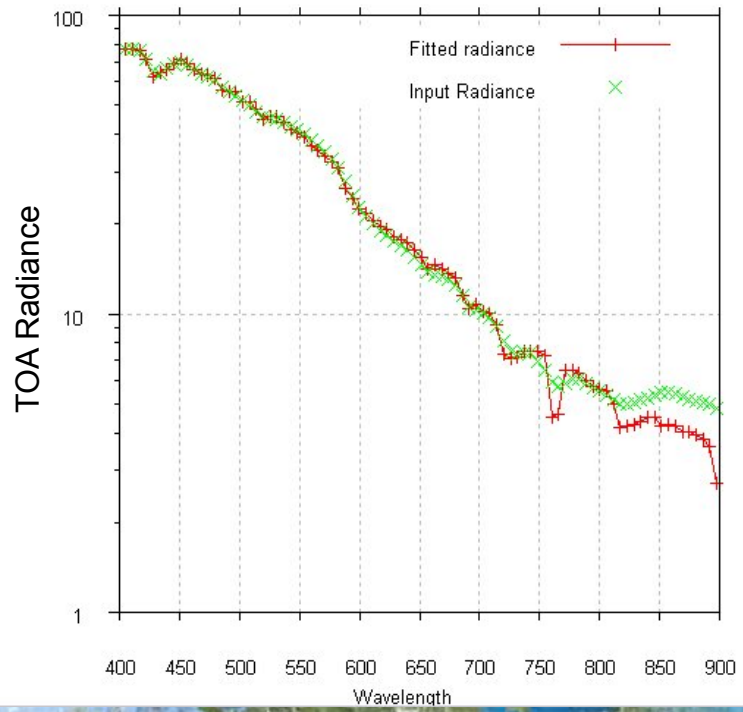
Aerosol retrieval over water using MIP

Pixel (292, 388)	Retrieved values	Aerosol type	Residual
	tau = 0.1000	maritime	0.3709E-02
	sm = 1.5551		Reflectance residual
	ph = 2.3887		0.1959E-04
	ys = 0.0726		

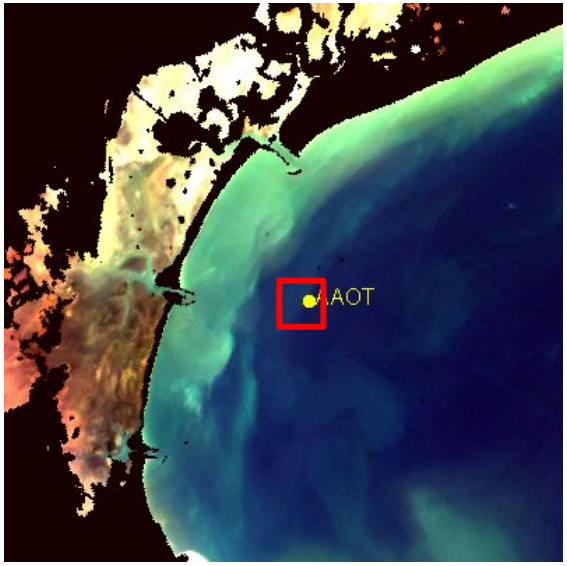


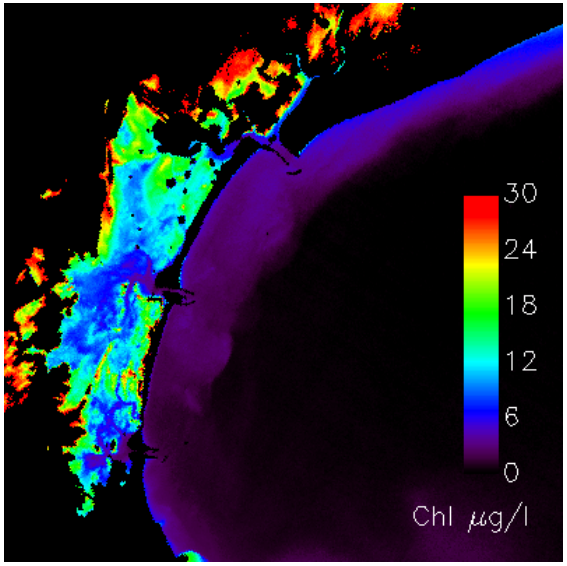


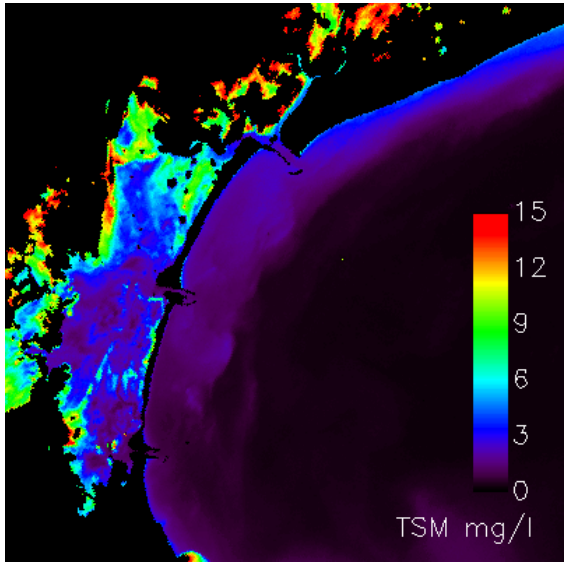
307.195, 2.99256

Water quality products using MIP

HICO Scene L1BM.AAOT.v03.7339 from 22nd July 2011 at AAOT in Venice







Chl µg/l **TSM mg/l**

"HICO™ Data provided by the Naval Research Laboratory."

Conclusion

- HICO data generally deliver useful spectral information for land and water applications
- It seems to be a radiometric calibration problem for channels beyond 750nm, because of consistent increase in clear water reflectance.
- It is anticipated to do further processing on HICO data using ATCOR and MIP to provide more detailed analysis.

Acknowledgement

- HICO Team at Naval Research Laboratory (NRL)
- Curtiss O. Davis and Jasmine Nahorniak, Oregon State University (OSU)
- Nicholas B. Tufillaro, Oregon State University (OSU)
- Giuseppe Zibordi at Joint Research Center (JRC)

Hyperspectral Imager for the Coastal Ocean

http://hico.coas.oregonstate.edu/

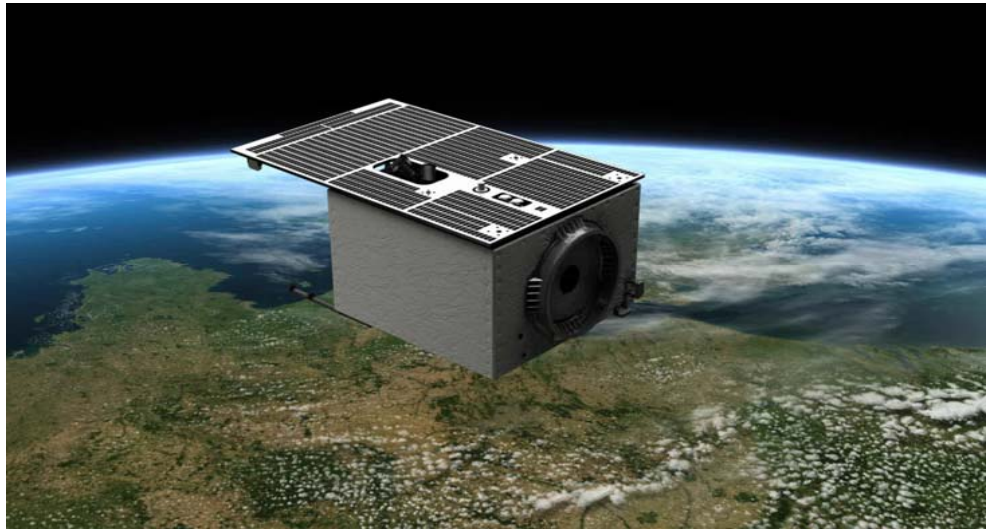
HICO Home

- HICO
  - Instrument Heritage
  - Instrument Design
  - Calibration
  - Example Data
- Meet the Teams
  - Instrument Team
  - Data Team
  - Science Team

What is HICO?

The Hyperspectral Imager for the Coastal Ocean (HICO; Corson, et al., 2008) is designed to provide 100 m ground sample distance hyperspectral imagery for coastal zones around the world. HICO is sponsored by the Office of Naval Research as an Innovative Naval Prototype (INP), and will demonstrate coastal products including water clarity, bottom types, bathymetry and on-shore vegetation maps. As an INP, HICO will also demonstrate innovative ways to reduce the cost and schedule of this space mission by adapting proven aircraft imager architecture and using Commercial Off-The-Shelf (COTS) components where possible.

EnMAP Hyperspectral Imager



Thank you very much for your attention.

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